Everyday cognitive science: using the methods of cognitive science to explore spatial thinking in related disciplines

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Abstract: This symposium will address how the breadth of investigation within the cognitive sciences can be brought to bear on applied everyday common problems, such as difficulties with reading charts and maps, and difficulties in using an in-car navigation device. Research with a problem-based focus often requires a systems approach that requires assimilation of work from many different disciplines. Such problems thus constitute ideal domains for illustrating the benefits of such multi-discipline and multi-method approaches. Speakers will focus on the use of spatial thinking in the context of examining these applied problems. These speakers span at least two disciplines, one a traditional discipline represented within cognitive science, and the other a related discipline such as geosciences and architecture.

Everyday Cognitive Science: Using the Methods of Cognitive Science to Explore Spatial Thinking in Related Disciplines

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Motivation

This symposium will address how the breadth of investigation within the cognitive sciences can be brought to bear on applied everyday common problems, such as difficulties with reading charts and maps, and difficulties in using an in-car navigation device. Research with a problem-based focus often requires a systems approach that requires assimilation of work from many different disciplines. Such problems thus constitute ideal domains for illustrating the benefits of such multi-discipline and multi-method approaches. Speakers will focus on the use of spatial thinking in the context of examining these applied problems. These speakers span at least two disciplines, one a traditional discipline represented within cognitive science, and the other a related discipline such as geosciences and architecture.

Spatial Thinking in Medicine
Madeleine Keehner

This talk will consider spatial cognition in the domain of medicine. Medicine involves many problems that are demanding of spatial thinking and spatial learning. These include learning about the spatial structures, spatial relations, and dynamic processes of human anatomy; understanding 2-D medical images (MRI, CT, X-ray, etc) by mapping these representations onto long term knowledge of 3-D anatomical structures; and operating within perceptually constrained and spatially demanding environments such as minimally invasive surgery and dentistry. These problems draw on a range of cognitive processes, including moment-to-moment fluid processes of mental representation and

manipulation, long term learning of knowledge and skills, and "embodied" processes of interacting with external tools and media. What they all have in common is a substantial reliance on spatial cognition. I will present research on performance in selected tasks and findings relating to individual differences. Potential implications for training and pre-selection of entrants will be discussed.

Spatial Cognition in the Real World: Is Spatial Cognition Everywhere?
Dan Montello

Researchers in several disciplines, including psychology, geography, neuroscience, linguistics, and computer science, have delimited an area of study known as "spatial cognition." Although one can find the roots of spatial cognition research in late 19th and early 20th century work, the past couple decades has seen greatly expanded interest in this area (technological developments, notably virtual reality and fMRI, are just part of the reason). Yet, it is surprisingly difficult to define explicitly what constitutes the domain of spatial cognition. I discuss the ontology of what makes a task spatial, what makes it cognitive, and what makes it spatial cognitive. I present a taxonomy of real-world tasks (as opposed to tasks on psychometric tests, in real or virtual laboratories, etc.) that seem substantially to involve spatial cognition. I also discuss efforts to develop explicit-report scales to assess individual and group differences in abilities performing real-world spatial-cognition tasks.

Visual Geoanalytics Methods to Evaluate the Cognitive Adequacy and Perceptual Salience of Visual Analytics Displays
Sara Fabrikant

Visual (geo)analytics is based on the intuition that interactive and dynamic depictions of complex and multivariate databases amplify human capabilities for (spatio-temporal) inference and decision-making, as they facilitate cognitive tasks such as pattern recognition, association, and analytical reasoning. But how do we know whether visual (geo)analytics really works?

I present evaluation approaches to support the systematical assessment of users' visual interaction and sense making strategies when using interactive visuo-spatial displays of geographic information. I review self-developed theory- and data-driven evaluation methods to assess the cognitive adequacy and perceptual salience of visual geoanalytics interfaces. The proposed approaches are applied to response data collected from human-subject experiments and include (eye movement) sequence similarity analysis, computational verbal-protocol analysis, and spatial analyses using geographical information systems (GIS). With these interdisciplinary methodological contributions we hope to provide a better understanding of how people use and make sense of highly interactive multivariate data displays to for knowledge construction in a geographical context.

Visualizing Sub-surface Geology: Characterizing Visual Penetrative Ability Using Embodied Cognition
Eric M. Riggs & Matthew Alles

Visual penetrative ability (VPA) is a skill required to visualize the three-dimensional (3-D) underground structure of layered rocks from two-dimensional (2-D) surface clues. VPA is a basic skill for any geologist, but is often difficult to teach. We conducted think-aloud, discursive interviews where introductory students solved geologic block-diagram visualization tasks. Analysis of student gestures made during problem solving from the perspective of embodied cognition yields insight into difficulties faced by students. Students with high VPA rapidly construct a three-dimensional mental model, and readily produce gestures and physical expressions illustrating their spatial understanding. Students with poor VPA tend to view external information as merely "gift wrapping" and do not perceive the internal structure. They also do not typically address spatial concepts through physical expression. We construct a process model for VPA that describes the origin of commonly observed errors at crucial steps, and accommodation strategies used by students struggling with this type of spatial visualization.

The Design and Experience of Architecture
Ruth Conroy Dalton

The practice of architectural design is an activity usually undertaken by professionals after many years of rigorous, specialist education and training. Conversely the everyday experience of inhabiting, moving around, understanding and remembering buildings is common to all of us and such skills are acquired gradually throughout our lifetimes, starting at a young age. This presentation will endeavor to

outline the different kinds of spatial thinking that architects and building users employ. It will identify the non-correspondences between these different activities and suggest potential communication problems that might arise as a result. One method of bridging this divide is to formalize spatial systems such as buildings by producing graphic visualizations that allow both groups to externalize their spatial thinking. Such externalized visualizations may serve as a common arena for discourse. It is suggested that the tools developed and employed by space syntax researchers may serve to fulfill this spatial communication role.